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New developments in assessing forest ecosystem services in Romania

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Abstract

Economic assessment of forest ecosystems is especially important for determining efficiency of investment in: biodiversity conservation, expansion of the national forest and rational use of forest resources, sustainable forest development. In Romania, although discussed and debated in recent years, this subject has generated and still produces theoretical, methodological and practical issues. Economic and social consequences of changes in forest ecosystems are difficult to predict. Changes in the dynamics of river basins, ecologic regions or wildlife systems, for example, can reduce or increase various aspects of human welfare. Without sufficient knowledge about the value of forest ecosystem services, consequences unpredictability tends to increase with the degree of change. This paper will address some issues related to estimating the economic value of forests in Romania and ecosystem services provided by forests. The methodology used includes: clarifying and defining the main methodological and operational concepts, charts and diagrams to describe correlations and mechanisms of forest functions, qualitative and quantitative assessment (tables, matrices) of ecosystem services, with identification of the most important benefits, analysis of main methods of economic assessment of forest ecosystem services with recommendations and conclusions.

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Keywords: forest ecosystems, ecosystem services,economic assessment;

1. Introduction

Although for a long time it is considered that forests meet a dual purpose, (1) physical-geographical and (2) anthropo-geographical (Fankhauser, 1921; Jacquot, 1931; Negulescu and Ciumac, 1959), in recent decades, after the

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plenary assertion and adoption of sustainable development concept worldwide, there have been important theoretical and methodological developments in the field of forestry management, due to the urgent need to recognize the most important issues of sustainable development, economic and environmental assessment , biodiversity conservation and climate change mitigation.

Economic assessment of forest ecosystems is especially important for determining the efficiency of investment in biodiversity conservation, expanding national forestry fund, rational use of forestry resources, sustainable development of the forest. In Romania, the subject, although it was discussed and debated in recent years, has caused and still causes theoretical - methodological and practical controversies.

This paper will address some issues related to estimating the economic value of forests in Romania and ecosystem services provided by forests. The main objective of this paper is economic substantiation of methods and techniques for estimating the value of ecosystem services provided by forests, through their functions.

2. Conceptual features and functions of forest ecosystems

Forest is the structural and functional prototype of natural ecosystems because it meets to a great extent, all the elements in a state of maximum stability, despite the extreme complexity and diversity.

Forests, as a result of the anthropogenic influence, often lose their self-healing capability for many years. Given the continuity of forests and soil in which they grow, we consider useful the following definition of forest (Platon I., 2014): *"The forest is a mezoecosistem, which consists of all land and wood resources, bushes and grasses that grow on it, animals and micro-organisms and other components of the natural environment, which are linked with the external environment, and that influence each other"*.

Forest ecosystem show a tendency to maximize stability by optimizing the structure of biocenosis, increasing complexity of biocenotic relationships and genetic diversity of populations within each community of life, strengthening the control of the biocoenosis over biotope, enhance environmental efficiency of the system

When analyzing ecosystem functions in general and its components, in particular, emerges an essential fact, namely an ecosystem has a characteristic dual functionality: one natural (or organic) and other socio-economic.

Ecological functionality is the quality of ecosystem components in the exercise of certain natural features whose joint complex consists of general serving as ecosystem - to transform energy into matter and organize them in different forms (Platon I., 2014). Natural and socio-economic functionality of forests (forest ecosystems) is characterized by their strong indirect influence on the environment and on economic and social development.

Main functions and traditional roles of forests have been researched and shown for over a century. In summary, it can be represented as follows:

- *Forest influence over formation and modeling of land cover (geomorphological role of forests*). Forests have played a key role in the accumulation of basement large deposits of coal in the Carboniferous period (350-280 million years BC.)
- *The influence of forests on climate (climatic role of forests). At local level, the forest has a similar effect with the proximity of the sea: diminish high temperatures in summer and upgrades cold ones in winter, reduce the temperature maximum and increases the minimum.* Thus regulates climate either every day or every year and makes it less excessively more consistently moderated (Muel, 1884). The variation in daily temperatures is lower than in the open. Influence of forest occurs especially in summer (Drăcea, 1920);
- *Influence of forest on soils (edaphic role of forests).* Forests strengthens disaggregated land and prevents movements, slumping, formation of sinkholes, bogged down valleys (Drăcea, 1920); forest fixes flying sands; forest prevents solar heat from reaching the soil and drying it; forest soil is more moist than the land discovered nearby (Simionescu, Zeicu, 1926). Therefore, "the forest had a senior role in formation of at least 75% of Romanian soils" (Giurgiu, 1995/1);
- *Influence of forests on water (hydrological role of forests).* Forest favors the formation of springs and ensures a constant and regular flow rate (Stătescu, 1884; Muel, 1884). To perform this function, hydroelectric river basins of interest should be as well as possible forested (Radulescu, 1956). Forest regulates flow rate, removing the extremes, due to fixing a considerable amount of water in the soil and allow surplus to flow, thus water flow becomes slower (Drăcea, 1920). Moreover, the forest is the strongest barrier against erosion, and accounted the best and most effective way to prevent floods (Simionescu, Zeicu, 1926; Rădulescu, 1956).

- *Influence of forests on agricultural crops*. Referred role appears in the context of regional climate and soil change related to forest, which contributes to the improvement of the vegetation of pastures, meadows and crops nearby. Thus protection forestry bands, placed perpendicularly to to the wind direction, significantly reduce its speed. Therefore, farmland protected by curtains give cereal crops on average 25-30% higher in normal years; in dry years, crop growth can be up to 300% from the field without curtains. This effect is due to the fact that curtains reduce evaporation and, in winter, help spread more evenly snow on the ground, which is no longer carried by wind but retained in the field (Rădulescu, 1956).
- *Influence of forests on human health (healthcare role of forests).* This influence is manifested both by its own environment _ and through resources offered. Thus forest purify the atmosphere; fixes carbon dioxide from the air and renders the necessary oxygen for breathing (Stătescu, 1884); in softwood forestsis added air and ozone enrichment caused by resin trees. The air in these forests is best for diseases followed by a long convalescence (Rădulescu, 1956).

From World Bank documents results that 1.6 billion people depend on forests for their daily needs secure. Labor employed forestry sector (sylviculture and forest exploitation) worldwide includes about 12.3 million people (FAO, 2007).

Besides all this research and valuable contributions to Romania, we need to emphasize the role and influence of forests in climate change, which became more obvious and social and economic effects can not be neglected. Current analyzes on environmental priorities notes that climate change along with biodiversity loss, overuse of natural resources and increasing amount of waste are the unprecedented challenges recorded at local, national and global level. Climate change is a complex process of change in long-term climatic elements (temperature, precipitation, increased frequency and intensity of extreme weather, etc.), primarily due to emissions of greenhouse gases from human activities, leading to imbalances in the atmosphere and favoring initiation of greenhouse effect.

The climate system a common resource in the entire biosphere, and its stability is already affected by emissions of carbon dioxide and other greenhouse gases (GHGs). The main reason of climate change is global warming, manifested by increasing the temperature at the earth's surface. Global warming is a phenomenon widely accepted by the international scientific community, already highlighted by analyzing observational data over long periods of time. The main factors that determine this phenomenon are either natural (variations in solar radiation and volcanic activity) or anthropogenic (changes in the composition of the atmosphere due to human activities). The cumulative effect of the two factors can explain the observed changes in global average temperature over the past 150 years.

Increasing concentrations of greenhouse gases in the atmosphere, especially carbon dioxide, was the main cause of pronounced warming in the last 50 years of the twentieth century. An increasingly important role goes to indirect emissions sources that contribute greatly to climate imbalance, in this regard may be referred deforestation and land use change. Is well known that carbon dioxide, the main greenhouse gas, can be retained through the process of photosynthesis by the plant mass of forest and vegetation on other land, process which in climate change is called carbon storage (Deac C., Borla M., Biri I., 2009).

Climate change researchers found that forests constitutes the most powerful natural CO_2 storage for long periods of time, but the amount stored decreases from year to year due to, in particular, massive deforestation. If CO_2 is captured, it can be stored or reused with economic benefits.

Since CO_2 reuse market is currently small, most CO_2 extracted must be stored (Figure 1).

Climate change is a serious problem because both our natural system and socio-economic lifetime are sensitive to these phenomena, and the extent and projected rates for these changes will have a significant impact, threatening the sustainability of the whole process of development of humanity.

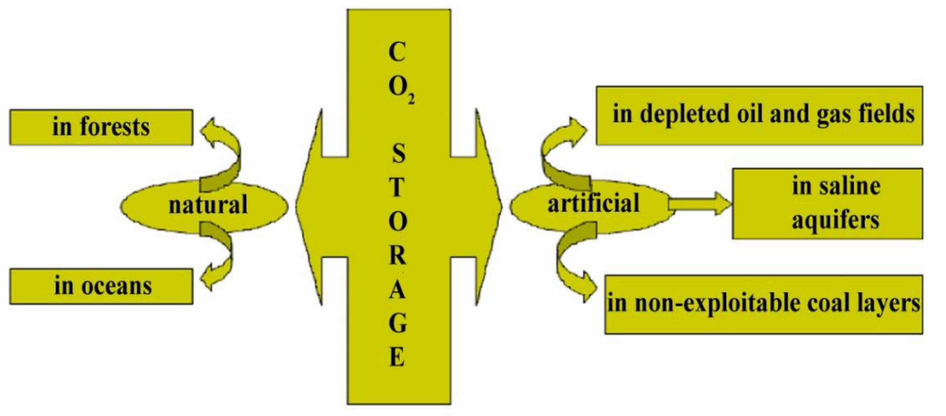

Fig. 1: Carbon dioxide storage possibilities

Moreover, keeping a parallelism with one of the economic meanings, forest economy can be defined as an optimal allocation of timber and non-timber forest resources to provide both base materials to manufacturing and multiple protective services (Drăgoi, 2008).

3. Methods for economic evaluation of forest functions

Besides all these important and traditional functions that are interrelated and integrated, natural phenomena in recent years and increasing awareness of sustainable development and green economy importance on a global scale, have led to higher valuation of ecosystem services of the forests.

It is worthy to note that services and functions of an ecosystem do not necessarily overlap perfectly. In some cases a single ecosystem service is the product of two or more ecosystem functions while in other cases a single ecosystem function contributes to two or more ecosystem services (Costanza R. et al., 1997). Also, as suggested above, it is important to emphasize and to be aware of the interdependent nature of ecosystem functions.

Ecosystem services (ES) refer to an outflow of resources or services in the environment that people benefit directly or indirectly. The Millennium Ecosystem Assessment (MA, 2005) presents a theoretical and methodological framework that helps identify the main ES, classifying them into four categories:

• *Provisioning ecosystem services*, that relate to forest ecosystems in tangible goods supplied, such as timber, non-timber forest products (NTFP), fishery products and pharmaceuticals provided by ecosystems;

• *Regulating ecosystem services* that relate to the natural processes of an ecosystem, such as carbon sequestration and water regulation, processes that provide services that contribute to social welfare;

• *Cultural ecosystem services*, referring to intangible benefits obtained from ecosystems (e.g. through tourism and education);

• *Supporting ecosystem services*, (e.g. soil formation and nutrient recycling) are those necessary to achieve the other ecosystem services. They are different from the other ES since their effects on people are either indirect (through the provisioning, regulating and cultural services) or occur after a very long time.

The economies and human settlements benefit of such regulating and supporting services of the natural forest ecosystems for a range of chemical and biological processes. Examples of forest ecosystem services benefits include: air and water purification, storm water and drought regulation, disease and pest control, waste assimilation and detoxification, formation and maintenance of soil, plant pollination, spreading seeds and recycling of nutrients, maintenance of biodiversity for agriculture, research and development of pharmaceutical and other industrial processes, protection against harmful UV radiation, climate stabilization (through carbon sequestration) and moderating of wind and temperature extremes.

People depend on these "free" services provided by ecosystems. Therefore, the forest ecosystem services annually are considered to be worth very much. Table 1 below summarizes the correlation between the provision of ecosystem services and their benefits for human welfare (a qualitative assessment).

Table 1: Ecosystem services of the forests and correlations to human welfare

	Ecosystem services (ES) of forests	Functions and outcomes	Human welfare benefits			
			Basic material for life	Security	Health	Good social relations
Supporting ES	Provisioning ES	Food; fresh water; fuel; fiber	***	**	**	*
	Regulating ES	Climate regulation; flow (flood) regulation; water purifiction; disease and pest control	***	***	***	*
	Cultural ES	Aesthetic; spiritual; educational; recreational services	*	*	**	**

Note: * = weak correlation; ** = medium correlation; *** = strong correlation;

As a result, economic development that destroys habitats and affect ecosystem services of forests can generate long-term costs for humanity that can thereby greatly exceed the short-term economic benefits of development. These costs are generally unrelated to traditional economic accounting, though, are real and are usually borne by society as a whole.

The concept of total economic value or full value of forest ecosystems is mainly the methodological support of the implementation of sustainable integrated management of natural resources, particularly forest resources, based on the complementarity of specific criteria of sustainable development: environmental protection, economic efficiency and social equity.

Total economic value (VET) includes several categories of value of environmental goods and services (of forest). VET includes:

- *Direct use values (VUD)* that relate to ecosystem goods and services that are used directly by human beings. These include the value of goods and services used in consumer products, such as harvesting of food, fuel wood or construction, raw materials for drugs, hunting animals for consumption; and the amount of use without consumption, such as that of public entertainement through recreational and cultural activities that do not require collection of products.
- *Indirect use values (VUI),* which are derived from ecosystem services that provide benefits outside the ecosystem itself. Examples include protection and regulation functions of forests: natural water filtration function of wetlands, storm protection function against coastal mangrove forests and forest carbon sequestration function that benefit the entire global community, through climate change mitigation. These functions usually affect activities directly measurable values, thus allowing their value to be estimated indirectly.
- *Option value (VO),* are deriving from preserving the option or the possibility of future use of ecosystem goods and services that can not currently be used either for oneself (option value) or others / heirs (heritage value)).
- *Non-utility values (VNU*), which mainly refers to the joy that people may have simply knowing that a resource exists, even if it is not expected to use this resource directly themselves(Drăgoi M., 2008).

From a theoretical perspective, overall economic value of forest ecosystem will be calculated by a simple mathematical relationship:

$$VET=VUD+VUI+VO+VNU$$

As we show below, the greatest challenge lies in the quantification of biophysical and monetary estimate most appropriate for each of the components of VET.

Economic evaluation of ecosystem services can help to demonstrate the benefits that ecosystems generate and to the increase of financial benefits (or avoided losses) conservation of these ecosystems can bring to people and stakeholders. However, it does not answer directly and specifically upon those measures or mechanisms that could provide sustainable financing for conservation of ecosystems.

The economic quantification of ecosystem services depends on whether or not the ES may be traded in the market, namely on the economic value component which is measured. Some of the most commonly used types of methods and techniques applicable to quantify ecosystem services are shown below (Figure 2).

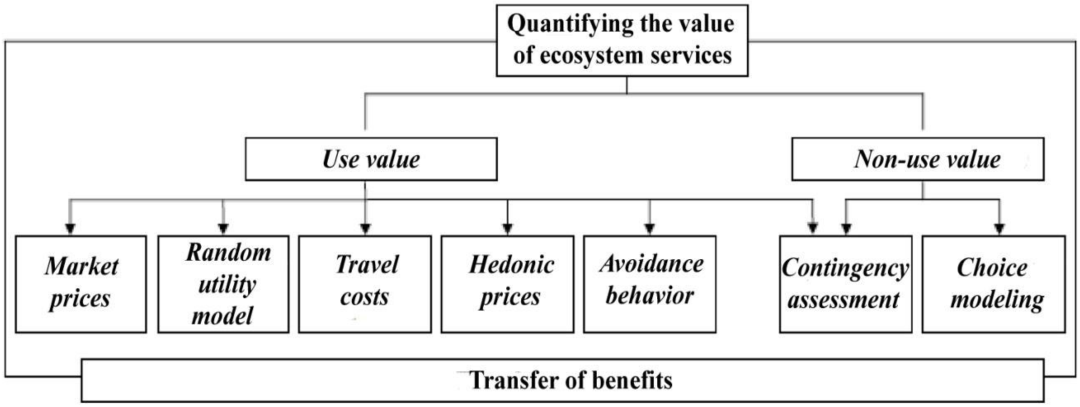

Fig. 2: Methods of quantifying the value of ecosystem services

The forest is an ecosystem consisting of biological populations; the size and structure of any biological population can only be estimated, not quantified with high precision. Regardless of the existence or non-existence of markets, TEV components can only be estimated with higher or lower accuracy, depending on the budget for evaluation. Also, the multifunctional importance of forest ecosystems determines the need to use different types of economic evaluation principles for their natural benefits. Although the forest is an entire ecosystem, it is not possible to assess the economic value by means of a single procedure. Therefore, the forest ecosystem must be examined as a totality of resources and services, each of which to be assessed independently (Platon I., 2014).

Given the structure of total economic value (TEV), evaluation is done only for ecosystem services with direct use value. Ecosystem services with indirect use value are those that help maintain the ones in the first category.

Among the methods and techniques for quantifying ecosystem services based on market mechanisms we will focus first on the following: the market price method, the productivity method, the hedonic price method and the travel cost method.

The *market price method* estimates the value of ecosystem services that are bought and sold on the market. The method can be used to assess changes in both the quantity and quality in the ecosystem service. It may use standard economic techniques for measuring the economic benefits of services offered, based on quantities purchased / provided at different prices. A total net economic benefit is the sum of consumer surplus and producer surplus. To estimate the consumer surplus a demand function should be estimated and data requirements include: time series on the amount corresponding to the price, data on other factors that may affect demand (income or other demographic information).

The *productivity method* is used to quantify ecosystem services that contribute to the production of a good or service which is traded in the market. This applies if the products or services provided by ecosystems contribute, along with other inputs, to the production of a commercial good (Grădinaru G., 2013). If an ecosystem service is a factor of production, changing its quantity or quality will lead to changes in the cost of production and the productivity of other inputs. Further, it will have an effect on the price and quantity supplied of a finished good. It can also affect the revenue per unit of input. The economic benefits resulting from improved ecosystem services can be estimated using changes in market data.

The *Hedonic Price Method - HPM* assigns a value for ecosystem services by estimating the statistical relationship between the evaluated system attributes and another good or service for which there is a market value. The value of land will be affected by the state of the neighbouring ecosystems. Economic analysis is based on the concept that the the property value is directly related to the present value of the stream of benefits derived from property (Pearce, Markandya, 1989). For the proper application of the method, it is necessary to have active markets, public customer awareness of the valued ecosystem services, and changes in supply to be discernible by the public, markets to be undistorted and transactions be transparent.

The *Travel cost method (TCM - Travel Cost Method)* - was proposed in 1947 by Harold Holding for estimating the value of national parks. It is a method designed to measure in monetary terms benefits derived from visiting the recreation areas. The cost of travel is considered an approximation of the price that visitors are willing to pay for ecosystem services. The economic assumption is that the demand is lower, the higher the price. The total benefit of the environmental resources is given by the area under the curve of demand (Rojanschi, 2003).

As regards the economic assessment of regulating forest ecosystem services, although there are some studies and methods applicable, it is still a conceptual-methodological and practical challenge not only in Romania but also in Europe and therefore it is considered a strategic objective for 2020. Thus most studies elaborated on the economic benefits of forest ecosystem services of regularization were made for developing countries and usually refer to tropical forests (Vincent J, 2012).

Other methods that can be used for economic assessment of hydrological and edaphical regulating ecosystem services of a forest (estimating the indirect use value of the forest) are proposed by (Barbier, 2000).

The *method of intermediate goods* is based on the assumption that in the presence of positive externalities or for the implementation of a project, goods and services have certain known prices. If these externalities would be missing, the same goods and services may have different prices, so the net income of companies or families would suffer harm.

The study Economic & Forest Management (Dragoi, 2008) analyses this methodological approach, emphasizing, in fact, some of its limitations. The hydrological and erosion protection represents very well these approaches: if law would not impose restrictions on cutting in interception basins of the storage lakes (art.30-31 of the Romanian Water Act), the rate of clogging in lakes would increase and the duration of the hydropower plants would be shorter. The total investment should be recovered in a shorter period, which would increase the price of electricity. Higher energy costs would result in higher prices for all goods and services produced and consumed in an economy. The primary data used in the assessment should cover the entire forest with watershed protective function.

Methods based on estimating the avoided costs or the replacement costs assume that for some regulating ecosystem services, substitutes exist so that these services can be estimated based on a cost-benefit analysis of these "shadow infrastructure projects" . In the case of the watershed protection function of forests there may be mentioned some infrastructure substitutes:

- Transverse and longitude correction works for the torrents are expensive projects that can substitute, when needed, the water flow (torrents) regulating forest ecosystem service. In an ambitious study (Dragoi et al., 2002) based on the statistical analysis of constructive elements for such transverse and longitudinal works, it was performed a multiple linear regression function, expressing the volume and amount of the masonry work made of reinforced concrete, depending on a number of explanatory variables, including the percentage of afforestation in interception basin as a proxy for the forest flow regulating ecosystem service;
- - There exist shadow projects for the substitution of a forest ecosystem service regulating (protecting) the quality of fresh water sources that supply an urban centre or more clusters. Thus, if, for example, these forests for the protection of the permanent water sources are particularly valuable from the point of view of wood resources, a quite precise estimate of the hydrological protection ecosystem services may be done by considering the additional cost of the detection and capture of other water sources, located at greater distances and certainly requiring large investments.

Nevertheless, Romanian experts in forestry economics (Dragoi M., 2008) consider that these shade projects for replacement of forest ecosystem services (which we seek to evaluate thereby) must be credible and realistic, suggesting that, for instance, measuring the hydrological protection exercised by forests surrounding a reservoir, by the cost of unclogging the reservoir lake, does not make sense and economic justification, besides being extremely expensive.

4. Conclusions, conceptual and methodological challenges

It is widely accepted that forests provide many benefits. Forests are home to protected animal species, help slowing down global warming through carbon storage and sequestration, are sources of wood products, essential sources of food and water, help regulate rainfall and erosion and bring enormous aesthetic, spiritual and recreation benefits for millions of people. As major global carbon deposits, forests play a fundamental role in influencing the Earth's climate and the entire ecosystem. In this context, given that man is part of the planet's ecosystem one can also raise the question whether forests could influence population mortality.

However, in this paper we tried to draw attention to some pointers on forest influence in economic development. Development and strengthening the economic evaluation methods for forest resources and services in Romania is particularly necessary to enhance the importance of the forest core and side products, with direct economic value and point to those categories of forest benefits with indirect economic value, conservation and option value, by stressing the invaluable, vital and irreplaceable character of the regulating and supporting ecosystem services.

Although an important motivation, economic evaluation of forest protection functions is not necessarily performed to directly compensate those who hold or manage protective forests, but to the justification and reasoning of environmental policies. This derives from the public good nature of the natural environment and ecosystem services, involving a drawback so that environmental investments are not attractive to the private sector because of the quasi-permanent issue of the not just individual "free-rider", but as an entire social group or a vital economic sector, such as the power industry for instance. In most cases, evaluation of forest protection function is done to justify indirect government intervention through fiscal policy differentials: additional taxation of activities generating negative externalities and subsidizing activities generating positive externalities (Dragoi, 2008).

Thus if wood and non-wood forest products may be replaced by other similar use products or may be imported at reasonable price from other countries rich in forest resources, the ecosystem or indirect economic services cannot be replaced or imported because *they are generated only in the presence of wooded areas*, especially near urban and agricultural land, transport routes, tourism and leisure infrastructure (Platon I., 2014).

To allow a better assessment of the economic value of natural services, to identify economic impact of the damage to ecosystems and thus to estimate the indirect costs of inaction, the European Commission initiated the study of The Economics of Ecosystems and Biodiversity (TEEB).

In practice, methods of economic evaluation for the most important types of natural resources recommend provisional assessment of the environmental and recreation role of the first functional forest group as the triple value of their exploitation, but not less than the cadastral evaluation of the arable land (Platon I., 2014).

Forest evaluation without considering environmental factors would result in losses difficult to recover in the functioning of natural ecosystems, with negative economic and social consequences. Moreover, the conditions of increasing labour industrialization and urban development increase the risk of degradation of forest ecosystems, which essentially leads to a further worsening of the ecological situation.

We also support the expression in quantitative values of the potential utility of forest ecosystem resources to become an important component in determining the composition of the national territorial (land) wealth, and in developing measures to stimulate a rational use of forest ecosystems.

With regard to the effective implementation of methods for assessing forest ecosystems and evaluating their services in our country, we can conclude the following:

- Resource (e.g. time, financial and skills) constraints determine which of the methods of data collection and evaluation can be implemented effectively. There are various challenges in terms of availability of data; availability in industrial countries is higher than in developing countries and in Romania progress is made especially after EU accession.
- Since almost all regulating ecosystem services are indirectly related to the ecosystems that generate these services, it is often necessary to conduct experimental studies to determine the correlation. Wherever previous studies have identified and assessed these links, the assessment task becomes much simpler, but rather this is not the case. It is believed that the geographic information system (GIS) and other similar geospatial techniques have the potential to contribute greatly to the creation and development of accurate models.
- It is difficult to understand completely the linkage between ecosystems, ecosystem functions, ecosystem services and human activities (Bingham et al. 1995), and this may lead to underestimation of ecosystem benefits. If the

estimated benefits are more than the benefits associated with alternative management regime which is likely to degrade the natural resources, economic valuation can be helpful. However, often due to very shallow understanding of the linkages, a very low value is estimated for the benefits of the ecosystem and therefore, an alternative policy which is likely to degrade the ecosystem is selected. The better our understanding and knowledge about ecosystem linkages, the better the economic valuations would be.

On the other hand, a forest ecosystem may have conflicting uses (e.g., the water purification and recreation) and in assessment care should be taken to avoid double counting. Problems occur when different service users have interests in different uses of an ecosystem and the uses are conflicting in nature (Turner et al. 1998). In such cases, there is dilemma of which services to consider for valuation.

In this situation, optimal management decisions typically must be made at a landscape level, not at the level of individual properties, with different parts of the landscape being managed in different ways (Vincent J., 2012). This way, the aggregate value of ecosystem services from a landscape will be higher if the supply of particular services is concentrated more in some locations than in others, instead of combining ("stacking") all services in all locations. This is obvious when ecosystem characteristics vary substantially within the landscape: for example, the combined value of timber and water quality will likely be maximized if logging is allowed only in forests on gentler slopes, with forests on steeper slopes being protected in order to safeguard water quality.

So far, in Romania, we spend enormous financial resources to rebuild the localities after floods and landslides and the ways of communication - roads, bridges, railways - destroyed by floods, but continuing the irresponsible destruction of protection forests, justifying these actions by respecting property rights (Giurgiu V., Clinciu I., 2006).

Our research will continue to the effective implementation of the most appropriate methods for the evaluation of forest ecosystem services and to analyses how the policy and forest legislation (new Forest Code) of Romania can provide protection and sustainable forest management to fully capitalize the most significant forest ecosystem services.

References

Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., o'Neill R.V., Parvelo J., Raskin R.G., Sutton P., van der Belt M., 1997. The value of the world's ecosystem services and natural capital, în: Nature 387, 15 May, pp. 253-260.

Barbier E.B., 2000, Valuing the environment as input: review of applications to mangrove-fishery linkages, Ecological economics 35:47-61.

Bingham G, et al., 1995. Issues in ecosystem valuation: improving information for decision making, Ecological Economics, p. 73-90.

Deac C.D., Borla M., Biri I., 2009, Captarea şi stocarea CO2 în vederea reducerii emisiei de gaze cu efect de seră, Simpozionul "Impactul Acquis-ului comunitar asupra echipamentelor şi tehnologiilor de mediu", Agigea.

Drăcea M., 1920. Tehnologie forestieră și Exploatarea pădurilor. Şcoala Superioară de Silvicultură, Bucureşti, 453 p.

Drăgoi M., 2008. Analiza cost-beneficiu a conversiei pădurilor naturale în plantaţii de plop, programul LIFE 2008.

Drăgoi et.al.2002. Elaborarea unei metodologii de evaluare economică a funcției antierozionale a pădurii, Seria I, vol.45, Ed. Tehnica Silvica, 2002, pp.157-165.

Fankhauser F., 1921. Guide pratique de Sylviculture. Librairie Payot & Cie, Lausanne et Genéve, 348 p.

Giurgiu V., 1995/1, Motivaţia protejării și întregirii patrimoniului forestier, în Protejarea și dezvoltarea durabilă a pădurilor României (sub red. V. Giurgiu), Editura Arta grafică, București, pp. 9-17.

Giurgiu V., Clinciu I., 2006. Pădurea şi Regimul Apelor, Editura Academiei Române, Bucureşti, Silvologie, vol.V 285p..

Grădinaru G., 2013. Metode şi tehnici pentru cuantificarea valorii serviciilor de ecosistem, Romanian Statistical Review nr. 5/2013.

Jacquot A., 1931. Manuel pratique de Sylviculture, Librairie J.-B. Baillière et Fils, Paris, 333 p.

Muel E., 1884. Notions de Sylviculture. Ducher et Cie, Editeurs, Paris, 224 p.

Negulescu E.G, Ciumac G., 1959. Silvicultura, Editura Agrosilvică de Stat.

Pearce and Markandya, 1989. Blueprint for a Green Economy, London Environmental Economics Centre.

Platon I., 2014. Metode de evaluare economică a resurselor forestiere (în baza materialelor agenției "Moldsilva"), Teza de doctorat în economie, Chişinău.

Rădulescu A.V., 1956. Silvicultura generală, Editura Agro-silvică de stat, Bucureşti, 336 p.

Rojanschi V., Bran F., Grigore F., Diaconu S., 2003. Abordări economice în protecţia mediului, Editura ASE, Bucureşti.

Simionescu, I., Zeicu, I., 1926. Noţiuni de Silvicultură. Tipografia "Artistică" P. Mitu, Piteşti, 304 p.

Stătescu G., 1884. Influenta și importanta pădurilor în România, precum și alte considerațiuni relative, Tipografia Frații Benvenisti, Craiova, 115 p.

Turner R.K, Adger W.N., Brouwer R., 1998. Ecosystem services value, research needs, and policy relevance: a commentary, Ecological Economics, p. 61-65.

Vincent J., Jeffrey R.. 2012. Ecosystem Services and Green Growth Policy Research Working Paper 6233, The World Bank Development Research Group, Environment and Energy Team &Sustainable Development Network Office of the Chief Economist October 2012 WPS6233 Public

xxx - FAO, 2007. State of the world's forests 2007. FAO, Rome, 157 p.

xxx - Millennium Ecosystem Assessment (MA): Ecosystems and Human Well-being: Synthesis, Island Press, Washington, DC. Copyright © 2005 World Resources Institute;

xxx- TEEB – The Economics of Ecosystems and Biodiversity (2008) The Economics of Ecosystems and Biodiversity: An interim report. European Commission, Brussels. URL: www.teebweb.org.